October 1979

HEAT STRESS

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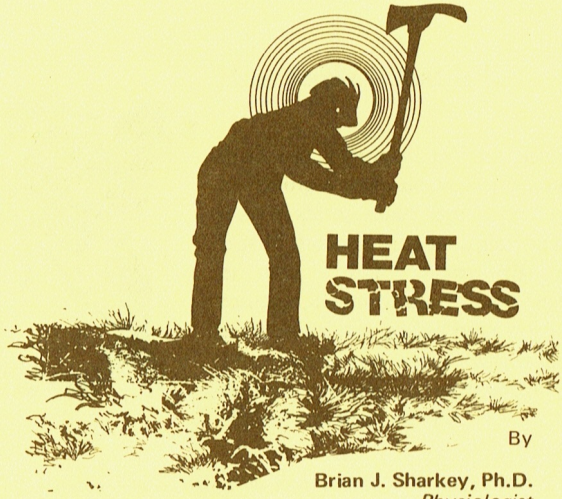

HEAT STRESS

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October 1979

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One of a series of publications on health, fitness, and work capacity developed by the Missoula Equipment Development Center.

Heat Stress—What Is It?

Wielding a pulaski on the fireline or hiking a steep slope with a heavy load is demanding work any time. But in the heat—under a glaring sun or near a flame front—it's even tougher. Sometimes the body can't cope with this added heat burden. The results can range from minor muscle cramps to exhaustion to often-fatal heat stroke.

Because firefighting is hot work, it's vital that you understand heat stress, how it affects you, and more important, what steps you can take to avoid it.

Heat stress occurs when humidity, air temperature, radiant heat, and too little air movement combine with heavy work and clothing to raise the body temperature beyond safe limits.

Sweat, as it evaporates, is the body's main line of defense against heat—as sweat evaporates it cools the body. In high humidity, sweating becomes more intense but doesn't evaporate, so no heat is lost. When water lost through sweating is not replaced, the body's heat controls breakdown and body temperature climbs dangerously, subjecting the body to heat stress.

Heat Stress Disorders

Heat Cramps

These painful muscle cramps strike workers who sweat profusely in the heat and drink large volumes of water, but fail to replace salt lost in sweating. Maintaining proper salt balance in body fluids is important. An imbalance causes tired muscles to cramp.

To treat heat cramps, drink lightly salted water (less than ¼ teaspoon salt per quart); tomato juice; or, if you prefer their taste, commercial "athletic" drinks. Static stretching exercises may relieve muscle cramps temporarily.

Heat Exhaustion

Heat exhaustion is characterized by weakness or extreme fatigue; unstable gait; wet, clammy skin; headaches; nausea; and collapse. It's caused by inadequate water intake, salt losses, or both. The fluid loss leads to a drop in blood volume that severely limits work capacity. Salt imbalance also reduces the working ability of muscles.

Treatment includes rest in a *cool place* and drinking lightly salted fluids.

Dehydration Exhaustion

This form of heat disorder can occur after several days of work in the heat. If water losses are not replaced daily, progressive dehydration can severely reduce work capacity. Weight loss is the best indicator of progressive dehydration. A loss of 2 percent or more is accompanied by diminished work capacity. Exhaustion and collapse may follow weight losses exceeding 5 percent.

Treatment includes fluid replacement and rest until water losses are restored.

Heat Stroke

Heat stroke results when the body's heat controls fail. It is characterized by:

- Hot skin (often dry).
- High body temperature (106^{O} F or higher).
- Mental confusion, delirium, loss of consciousness, convulsions, coma.

Heat stroke is a *medical emergency.* Send for medical help at once and begin treatment *immediately.* Brain damage and death may result if treatment is delayed.

Rapidly cool the victim by soaking clothing with cold water and fanning vigorously to promote evaporative cooling. Continue until temperature drops. Treat for shock if necessary once temperature is lowered.

Preventing Heat Stress

It's not enough to know how to recognize and treat heat disorders. You must know how to prevent them. There are two keys: physical fitness and acclimatization.

Fitness

Maintaining a high level of physical fitness is one of the best ways to protect yourself against heat stress. The physically fit worker has a well-developed circulatory capacity, as well as increased blood volume—important in regulating body temperature.

Fit people work with lower heart rates and body temperature. They start to sweat at lower body temperatures.

Fit workers adjust, or acclimate, to work in the heat almost *twice* as fast as unfit persons. Fit workers lose acclimatization more slowly, and are able to reacclimatize rapidly when again exposed to the heat.

Unfit workers who are overweight are even more unsuited for work in the heat. They have more weight without much increase in surface area for sweat evaporation.

The person acclimated to work in the heat runs less risk of heat stress. The body adjusts to hot work in 4 to 8 days by:

- Increasing sweat production.
- Improving blood distribution.
- Decreasing skin and body temperature.
- Decreasing heart rate (beats per minute for the same job may drop from 180 to 150).

Acclimatization may be hastened by taking 250 milligrams of vitamin C daily.

About 1½ hours of work a day in the heat is enough to acclimatize to a specific combination of work and heat. It provides partial acclimatization to more severe conditions.

Adjust to hot weather activity gradually. Set a sensible pace, take frequent breaks, replace fluids, and don't expect full production for the first few days.

Acclimatization persists for several weeks, but a tough weekend (fatigue, alcohol) leads to some loss.

HEAT STRESS

When heat and hard work combine to drive the body temperature up, the temperature-regulating mechanism begins to fail and the worker faces serious heat stress disorders. This dangerous—often deadly—combination of circumstances can be avoided by monitoring the work environment with simple measurements of temperature and humidity. This chart can help alert workers to dangerous heat stress conditions.*

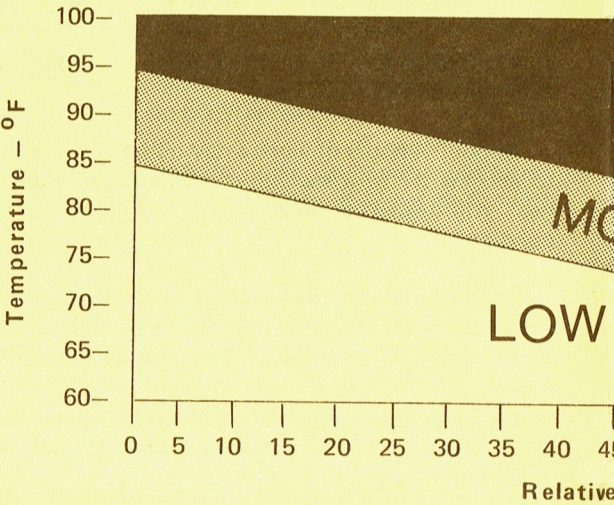
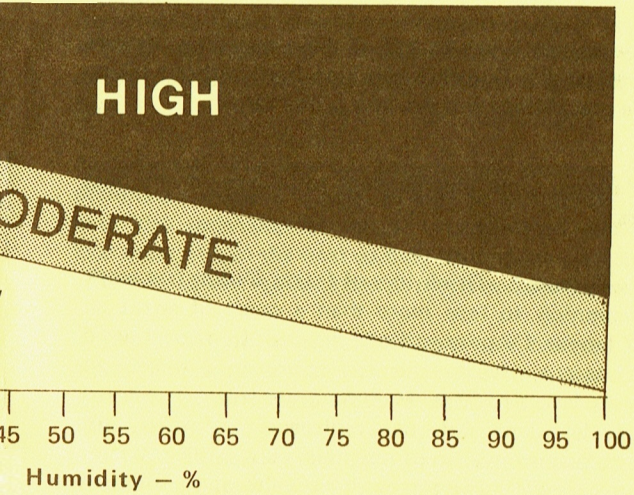


*Chart is based on shaded air temperature, moderate radiant heat from sun, light breeze, standard firefighter clothing, and moderate work rate on fireline. Non-acclimated or unfit workers will suffer at lower levels of heat or work.

Extreme heat stress conditions. Only heat acclimated workers can work safely for extended periods. Take frequent breaks and replace fluids.

Watch for changing conditions. Heat sensitive and non-acclimated workers may suffer. Increase rest periods and be sure to replace fluids.

Little danger of heat stress for acclimated workers. Lack of air movement, high radiant heat (from sun or fire) and hard effort can raise danger.



On the Job

Your best defense against heat stress is knowing when it is likely to strike. Temperature and humidity are your best clues:

- Is it hot—thanks to sun or nearby flames?
- Is the air still, with no breeze for cooling?
- Is sweat dripping off your body?
- Are you breathless, dizzy, chilled, nauseous?
- Is your heart pounding at a rapid rate?

If the answer is yes to any of these questions, beware of heat stress. Continue working hard without taking some precautions and you're a prime target.

Here are some specific steps to take to prevent heat stress:

Replacing Fluids. Drink lots of fluids. During hot work it's common to lose *more* than a quart of sweat an hour (about 1½ percent body weight). In a hot, humid environment, sweat rates can approach 3 quarts an hour for short periods. Maximum sweat loss in 8 hours is 8 to 12 quarts. Adequate replacement of water, salt, and potassium is vital to maintain your work capacity and to avoid heat cramps, heat exhaustion, or heat stroke.

To prevent dehydration:

- Drink 1 or 2 cups of juice or water before beginning work.
- Take frequent drinks during each hour of work.
- Drink as much as you can at lunch and at the evening meal.
- Continue replacing fluids throughout the evening.

Remember, thirst always underestimates fluid needs. It's not easy replacing 8 or more quarts of fluid a day, but it must be done when performing hard work in the heat.

Replacing Salt. Replace salt lost through sweating. Fit, acclimated workers should be able to accomplish this with the saltshaker at meals. Unacclimated workers lose more salt in the heat so they should pay particular attention to salt replacement at meals and during work.

Don't overdo it though. Avoid salt tablets. Too much salt impairs temperature regulation, and heat disorders become more likely. Don't continue high salt intake when you return to a cool climate or less arduous job. Excessive salt can cause stomach distress, muscle soreness, fatigue, impaired heart function, high blood pressure, potassium loss, and mental confusion.

Replacing Potassium. Potassium can become depleted over extended periods of work in the heat, so make potassium-rich foods like bananas and citrus fruits a regular part of your diet. Another approach is to drink lemonade, or tomato juice then water, in quantities comparable to the fluid loss. Commercial "athletic" drinks also help make up potassium losses.

Work Habits. Pace yourself. There are individual differences in heat tolerance. If you push too hard to keep up with others, you may not last the whole work shift. When possible:

- Avoid working close to heat sources.
- Do hardest work during cooler morning or evening hours.
- Change tools or tasks to minimize fatigue.
- Take frequent 10- to 30-second rest breaks as you work.

Rest Periods. Work-rest cycles must be adjusted to prevent progressive fatigue. Shorter work periods and more frequent rest periods in a cool, shaded area minimize heat buildup and progressive fatigue. Experience has shown that when:

Your pulse rate is under 110 beats a minute (after 1 minute of rest)

or

Under 100 after the 3d minute of rest

heat stress is *unlikely* during the workday. Ignoring these facts leads to fatigue and increased risk of heat disorders.

Protective Clothing. Modern fire-resistant garments protect against sparks, embers, and brief exposure to direct flame, but the fabrics that provide such protection reduce airflow through the garment. Wear cotton T-shirts and undershorts to aid sweat evaporation. Avoid layers of clothing (*vests,* wool shirts, and so forth) that add to the heat stress problem.

Stresses Add Up

- Physical work in a hot environment is far more demanding.
- Heat stress and carbon monoxide (CO) have a greater combined effect than they do separately.
- Heat stress, fatigue, CO, and noise lead to more mental errors and a definite safety risk.
- Physical work, heat stress, and prolonged work periods combine to pose a threat to health and safety.

The Missoula Equipment Development Center would like to thank Drs. Francis Dukes-Dobos, Ralph Goldman, Elizer Kamon, and Chris Wells for reviewing this publication and for their many helpful suggestions.

Recognizing and Treating Heat Stress Disorders

Heat Stress Disorder	Cause
Heat cramps	Failure to replace salt lost in sweating.
Heat exhaustion	Failure to replace water and salt lost in sweating.
Dehydration exhaustion	Failure to replace water losses over several days.
Heat stroke	Total collapse of temperature regulating mechanisms.

Symptoms	Treatment
Painful muscle cramps.	Drink lightly salted water or lemonade; tomato juice, or "athletic" drinks; stretch cramped muscle.
Weakness, unstable gait, or extreme fatigue; wet, clammy skin; headache, nausea, collapse.	Rest in shade and drink lightly salted fluids.
Weight loss and excessive fatigue.	Drink fluids and rest until body weight and water losses are restored.
Hot skin; high body temperature (106^{O} F or higher); mental confusion, delirium, loss of consciousness, convulsions.	Rapidly cool victim immediately, either by immersing in cold water or soaking clothing with cold water and fanning vigorously to promote evaporative cooling. Continue until temperature drops below 102^{O} F. Treat for shock if necessary once temperature lowered. Heat stroke is a medical emergency. Send for medical help and begin treatment at once. Brain damage and death result if treatment is delayed.

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1979—699-953

U.S. Department of Agriculture
Forest Service
Equipment Development Center
Missoula, Mont. 59801